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TRICORYTHODES MINUTUS TRAVER, A NEW SYNONYM OF *TRICORYTHODES EXPLICATUS* EATON (EPHEMEROPTERA: LEPTOHYPHIDAE)

DAVID E. BAUMGARDNER

Department of Entomology, Texas A&M University, College Station, Texas 77843-2475, U.S.A (e-mail: dbaumgardner@tamu.edu)

Abstract.—Based upon a study of adults, larvae, and reared adults from throughout North and Central America, *Tricorythodes minutus* Traver, 1935 is shown to be a junior synonym of *Tricorythodes explicatus* (Eaton, 1892) **(n. syn.)**. Previous characters postulated to separate the two species are shown to be variable and unreliable. This study has clearly revealed the presence of a single, widespread and morphologically variable species distributed throughout much of western, central, and northeastern North America and northern Central America.

Key Words: Ephemeroptera, Leptohyphidae, *Tricorythodes explicatus*, *Tricorythodes minutus*, taxonomy

Among Nearctic *Tricorythodes*, the exact identities of *T. explicatus* (Eaton) and *T. minutus* Traver have remained vague and uncertain. Although Kilgore and Allen (1973) and Allen and Murvosh (1987) described the larval stages of these two species and contrasted their larval characters, much taxonomic confusion still remained. The possibility that these two species might be synonymous has been mentioned in the literature several times (Lugo-Ortiz and McCafferty 1995, McCafferty et al. 1997, Baumgardner and Bowles 2005). After an extensive study of numerous specimens from throughout North and Central America (which included larvae and reared adults), it is apparent that both are the same species. The purpose of this paper is to trace the historical taxonomy of the two species (and two associated species synonymized with *T. minutus*), and justify the synonymy of *T. minutus* with *T. explicatus*.

* Accepted by David R. Smith

MATERIALS AND METHODS

Collections (and their acronyms) housing materials used in this study include: The Natural History Museum, London (BMNH), C.P. Gillette Museum of Arthropod Diversity, Colorado States University, Ft. Collins (CSU) and Texas A&M University, College Station (TAMU). In material examined summaries, larval collections are abbreviated by the capital letter "L," preceded by the number of specimens examined. Collectors are identified by the following initials: DEB (David E. Baumgardner); BCK (Boris C. Kondratieff). Legs, gills, and mouthparts of over 40 specimens were removed and mounted on slides for detailed study. Figures were drawn using a camera lucida. Global positioning measures are given in longitude/latitude coordinates as degrees,

minutes, seconds. Setal descriptive terminology follows Baumgardner and Ávila (2006).

Results and Discussion

Tricorythodes explicatus was described by Eaton (1892), as *Tricorythus explicatus*, based upon a series of adults collected by Herbert Knowles Morrison (1854–1885) from "N. Sonora, Mexico." However, it appears highly likely that the type series was collected from the Graham Mountains north of Fort Huachuca in extreme southern Arizona (Selander and Valurie 1962). Morrison was a professional collector who collected in Arizona in 1880 and 1882 (Essig 1931). Horn (1886) notes that "The collection made by Morrison teaches very little. How far he went below the boundary I do not know, although my series was purchased as from Arizona purely, and the same series is quoted by the authors of the "Biologia" as from northern Sonora." It appears that perhaps Morrison, as a commercial collector, labeled his specimens from extreme southern Arizona as being from northern Sonora (Mexico) so that he could then sell them to the Biologia researchers as being from their area of interest. To the American scientists, he apparently gave them the correct Arizona locality. Despite this apparent error in labeling, Essig (1931) considered Morrison one of the greatest American entomological explorers, with extensive collections made throughout the western and southeastern United States. Morrison contracted a fatal case of dysentery on his last collecting trip to Key West, Florida in 1885 (Essig 1931).

The original brief description by Eaton (1892) focused upon coloration and included two figures, one of the wing and one of the forceps (without the penes). Since a holotype was not designated in the original type series, Kimmins (1934) designated a specimen from this series as the lectotype. This specimen is clearly labeled as such in The Natural History Museum. Ulmer (1920) established the genus *Tricorythodes* and designated *Tricorythus explicatus* as the type species. Banks (1903) documented the species for the first time in the United States from Arizona, and McDunnough (1931) listed it as occurring in Texas and Wyoming in the United States and Saskatchewan and Alberta in Canada. Traver (1935) questioned the identification of the specimens from Canada, while Allen and Murvosh (1987) considered them to be *T. minutus*. Spieth (1941) indicated that the species occurred as far north as Yellowstone Park in Wyoming. Allen and Murvosh (1987) described the larval stage of *T. explicatus* based upon specimens collected from what they believed was the type locality of the species in Sonora, Mexico. They also included a taxonomic key to separate *T. explicatus* from *T. minutus*.

Tricorythodes minutus was described by Traver (1935) from adults from the Provo River in Utah. It was distinguished from other known *Tricorythodes* adults on the basis of coloration (paler than *T. stygiatus* McDunnough) and lack of black maculation on the femora and tibiae (present on *T. allectus* (Needham)) and from *T. texanus* Traver due to its much darker coloration and more shallow excavation of the apical margin of the styliger plate. Kilgore and Allen (1973) described the larval stage of *T. minutus* and listed it as occurring throughout Arizona and New Mexico. Among characters they listed for the larvae of *T. minutus* were a 3-segmented maxillary palp, presence of long marginal setae on the femora, abdominal terga 7–9 with well-developed posterolateral projections, and operculate gills pale with black markings (Kilgore and Allen 1973: fig. 37). *Tricorythodes minutus* was subsequently reported from throughout western North America (Allen and Murvosh 1987, McCafferty et al. 1993, Lugo-Ortiz and McCafferty 1995, McCafferty

et al. 1997). It has also been reported from north central and northeastern North America (Alba-Tercedor and Flannagan 1995, Randolph and McCafferty 1998).

Two other species of *Tricorythodes*, *T. fallax* Traver and *T. fallacina* McDunnough, had previously been synonymized with *T. minutus*. *Tricorythodes fallax* was described by Traver (1935) from adults from California, and its overall similarity to *T. explicatus* was noted by Traver who distinguished it by its paler coloration. Edmunds et al. (1976) synonymized *T. fallax* with *T. minutus* because the two species completely intergraded along the borders of California, Oregon, and Washington. They considered *T. fallax* a "clinal variant" of *T. minutus*.

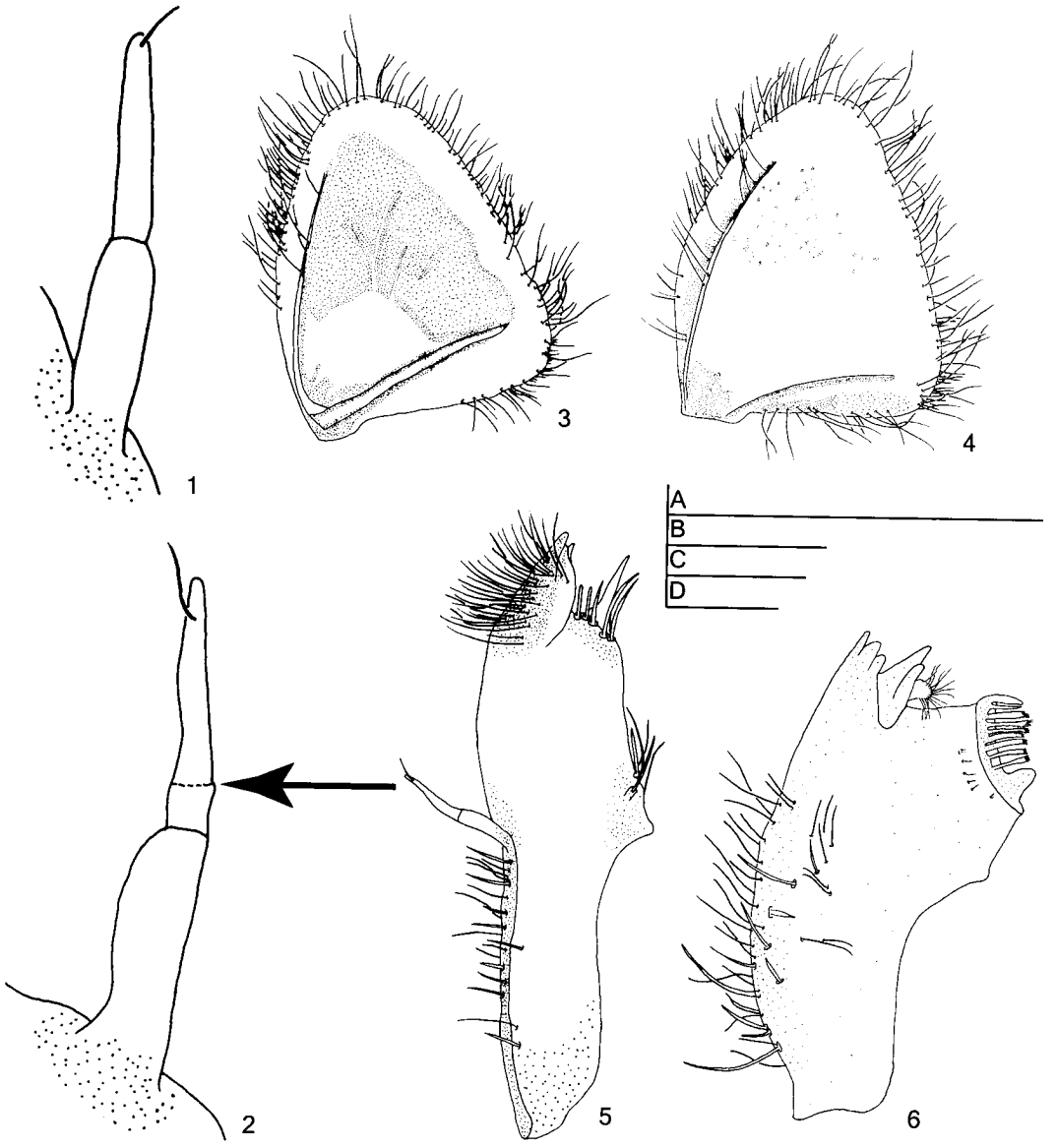
Tricorythodes fallacina was described by McDunnough (1939) from adults from British Columbia, Canada. The new species was considered a "smaller, more northerly species" within the *T. explicatus* complex. McDunnough (1939) considered *T. explicatus* to be a large dark species occurring in Texas and adjoining regions and *T. fallax* a smaller, paler western species. Traver (1935) and McDunnough (1939) noted that all three species shared morphological characters such as the type and shape of genitalia and a shallow excavation of the apical margin of the styliger plate. Edmunds and Allen (1957) synonymized *T. fallacina* with *T. minutus* without comment. However, this synonymy appears to be well justified on the basis of discussion given in Edmunds et al. (1976) discussing the clinal variants of *T. fallax*, *T. fallacina*, and *T. minutus*.

Thus, characters used to separate the adult stages of *T. explicatus* from *T. minutus* are few and based upon differences in overall size and coloration. I have examined long series of adults from western North America, Mexico, and Guatemala which would be attributed to *T. explicatus* and *T. minutus*, including varieties occurring in what would normally be considered the range of *T. explicatus* or *T. minutus*, and can find no reliable characters in the adult stage separating the two species.

As no characters were found to separate the two species in the adult, the larval stages of each species were examined. Although the key of Allen and Murvosh (1987) and characters given for the larval stage of *T. minutus* by Kilgore and Allen (1973) appear to offer many distinguishing characters, these characters proved unreliable and sometimes incorrectly applied.

Firstly, Kilgore and Allen (1973) indicated that *T. minutus* possessed a 3-segmented maxillary palp, whereas Allen and Murvosh (1987) indicated that *T. explicatus* possessed a 2-segmented maxillary palp. Examination of numerous larvae from throughout the reported range of *T. minutus* showed that all possessed a 2-segmented maxillary palp with a single apical seta (Fig. 1); however, some individuals possessed a weakly developed articulation near the base of the second segment, giving the appearance of a 3-segmented maxillary palp (Fig. 2). This condition of a weakly articulated palp has been demonstrated for other leptohyphid mayflies such as *Vacupernius packeri* (Allen) (Baumgardner 2003) and some South American *Tricorythodes* (Molineri 2002). None of the larvae examined possessed a 3-segmented maxillary palp; all possessed a 2-segmented maxillary palp, with about 10% of the larvae having traces of the weakly developed articulation.

Secondly, Kilgore and Allen (1973) indicated that *T. minutus* possess well-developed posterolateral projections on abdominal terga 7–9, whereas in *T. explicatus*, terga 7–9 lacked well-developed posterolateral projections (Allen and Murvosh 1987). However, examination of numerous larvae throughout the reported range of *T. explicatus* clearly



Figs. 1–6. *Tricorythodes explicatus*, mature larva. 1, Maxillary palp [Scale bar A]. 2, Maxillary palp (arrow indicates location of weak suture line) [A]. 3, Operculate gill (dorsal), "typical form" [B]. 4, Operculate gill (dorsal), "pale form" [B]. 5, Maxilla [D]. 6, Left mandible [C]. Scale bars (mm): A, D = 0.1; B = 0.5; C=0.2.

indicated some variation in the degree of development of the posterolateral projections on abdominal terga 7–9, including both larval instar and gender. For example, examination of almost 100 male and female larvae from Queretaro, Mexico (located in south-central Mexico) possessed posterolateral projections on terga 7–9, in addition to a 2-segmented maxillary palp. These larvae were identical to *T. minutus* larvae throughout the western United States. In general, more mature larvae, and female larvae, possessed more extensively developed posterolateral projections on terga 7–9 than male and/or immature larvae.

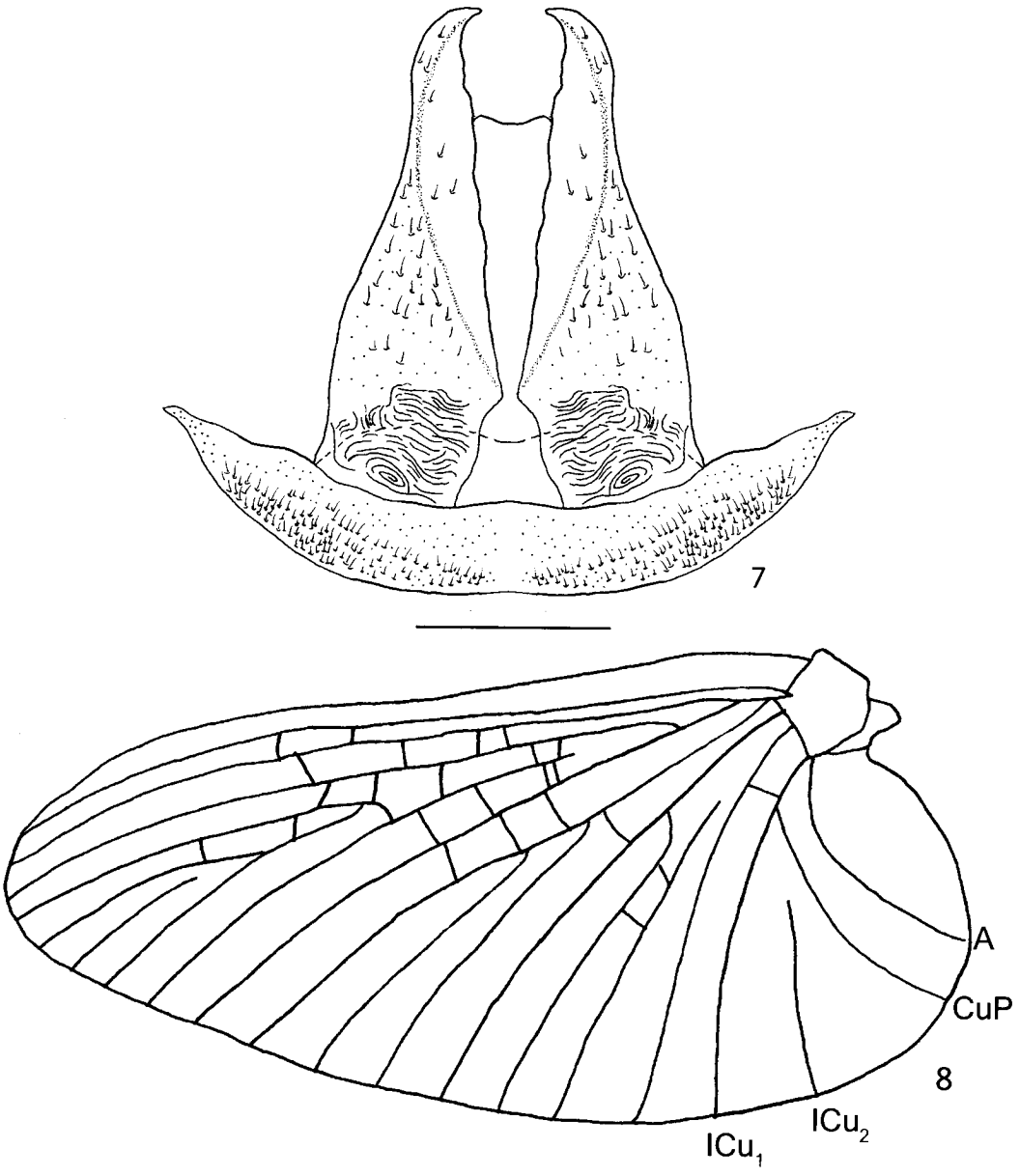
Thirdly, Allen and Murvosh (1987) distinguished *T. explicatus* larvae from *T. minutus* larvae based upon leg setation. Their key indicated that *T. explicatus* possessed a "double row of long, heavy spines" on the inner margin of the front and middle tibiae and had "short, heavy spines on the inner margin of all tarsi" (Allen and Murvosh 1987: fig. 1), while *T. minutus* larvae lacked these spinelike setae on the inner margin of the front and middle tibiae and tarsi (Allen and Murvosh 1987: fig. 3). Both comparisons were incorrect. While larvae within what is considered the range of *T. explicatus* did possess the described leg setation, so did all larvae examined from within what is considered the range of *T. minutus*. In addition, all known species of *Tricorythodes* larvae in North America possess setae on the inner margin of the tibiae and tarsi. If these tarsi become broken away, or the leg is slide mounted in such a way as they are not visible, the spinelike setae may appear absent. However, careful examination will reveal sockets from which the setae arise. It appears that either Allen and Murvosh (1987) were examining larvae with these setae broken away or perhaps were not examining the legs under high magnification. In any case, the characters used to separate these two species in the larval stages are clearly artificial.

Finally, the figure used by Allen and Murvosh (1987: fig. 2) to diagram the operculate gill of *T. explicatus* appears to be the same exact figure used by Kilgore and Allen (1973: fig. 37) to illustrate the operculate gill of *T. minutus*.

Almost all larvae examined from what Allen and Murvosh (1987) considered the range of *T. minutus* matched the description of *T. explicatus* and not *T. minutus*. Those larvae examined from central Mexico and Guatemala also match the description of *T. explicatus* and not *T. minutus*. It appears that the characters proposed by Allen and Murvosh (1987) to separate the two species in the larval stage were artificial or erroneous. Given the lack of any distinct, stable morphological characters to separate the species, it is clear that *T. minutus* is a synonym of *T. explicatus* and that a single, widely distributed and morphologically variable species is present throughout western, north-central, and northeastern North America.

Perhaps the most distinctive morphological feature present on larvae of *T. explicatus* is the pale, triangular shaped macula on the operculate gill (Fig. 3). This feature will readily distinguish *T. explicatus* larvae from all other known *Tricorythodes* larvae in North America. It is important to note, however, that this feature is somewhat variable among individual specimens. As some larvae reach the final instar, the black maculae largely disappear, and the operculate gill becomes mostly pale, with black maculae confined to the base and outer margin (Fig. 4). This phenomenon has been observed for a number of individuals in a variety of populations.

Tricorythodes explicatus is a highly variable species in terms of its body size and adult coloration. During the course of this study, it was extremely rare to find large series of individuals from a single population that clearly match a description of *T. explicatus*, *T. minutus* or *T. fallax*. It was more common to find a mix of individual specimens matching the various concepts of each of these species. The "pale gill" forms were often small individuals with very pale adult coloration, the reared adults of which were similar in coloration to that described for *T. fallax*; however, these individuals were typical of the size range of *T. minutus*. The *T. explicatus* form (large and very dark in coloration, i.e., browns and blacks) is common in collections from numerous locations from the extreme southwestern United



Figs. 7–8. *Tricorythodes explicatus*, lectotype male imago. 7, Penes (dorsal). Scale bar = 0.1 mm. 8, Forewing. Scale bar = 0.5 mm.

States, through the Rocky Mountains, and did appear to be the most common variant. Larval characteristics of the maxilla, mandibles and the two operculate gill patterns remain constant in individuals from throughout the range of *T. explicatus*. The shallow excavation of the apical margin of the styliger plate was present in all adult specimens examined (Fig. 7). The lectotype and paralectotypes of *T. explicatus* were of the *T. minutus* size with the coloration as in the description of *T. explicatus*. This was yet another

indication of the equivalency of these species.

In summary, characters postulated by Allen and Murvosh (1987), such as the number of segments of the maxillary palps, and differences in leg setation and abdominal posterolateral projections are unreliable and largely artificial characters. Characters proposed to separate the adults of the two species are based upon size and coloration differences and are not sufficient to diagnose two distinct species. Examination of large numbers of individuals throughout the range of the species has clearly demonstrated a single, morphologically variable and widespread species. The known range of *T. explicatus* includes southern Canada, western, central, and northeastern North America, south to Mexico and Guatemala. The larvae can be found in a vast variety of aquatic habitats from small, temporary streams to larger rivers.

Tricorythodes explicatus (Eaton)
(Figs. 1–8)

Tricorythus explicatus Eaton 1892: 11.
Tricorythodes explicatus: Ulmer 1920: 51 (transferred to *Tricorythodes*).
Tricorythodes fallax Traver 1935: 634; Edmunds et al. 1976: 259 (synonym of *T. minutus*).
Tricorythodes fallacina McDunnough 1939: 53; Edmunds and Allen 1957: 322 (synonym of *T. minutus*).
Tricorythodes minutus Traver 1935: 636. **N. syn.**

Diagnosis.—In the larval stage, *T. explicatus* can be distinguished from all other North and Central American species by the following combination of characters: (1) operculate gill with prominent basal ridge and much less prominent external ridge; often with large, pale macula at base of gill (Fig. 3); (2) maxilla with numerous elongate setae along outer basal margin below maxillary palp (Fig. 5); maxillary palp 2-segmented (Fig. 2); some individuals with faint annulation giving appearance of 3-segmented maxillary palp (Fig. 2); (3) mandibles with numerous, elongate setae along out margin (Fig. 6); (4) abdominal terga 2–9 with extensive black coloration across dorsum of each tergum, contrasting strongly with white to pale yellow base coloration of each abdominal segment; segment 10 with little, if any, coloration.

In the adult stage, *T. explicatus* can be distinguished from all other North and Central American species by the following combination of characters: (1) penes of typical *Tricorythodes* form but with very shallow excavation of apical margin of styliger plate (Fig. 7); (2) forewing (Fig. 8), veins A and CuP well developed, reaching wing margin; vein CuP not strongly curved towards A not meeting at wing margin; vein ICu_2 well developed, free, not meeting with vein ICu_1.

Type material examined.—*Tricorythodes minutus* Traver. *Holotype:* male imago (Cornell University). Type Locality: USA: Utah: Provo River, 22.vii. 1926. Condition poor, faded, with wings missing; preserved in ethyl alcohol. *Paratypes:* Same data as holotype; 8 male imagos, all in poor condition.

Tricorythodes explicatus (Eaton). *Lectotype* (designated by Kimmins 1934): male imago. Verbatim label data [bracketed information added]: (1) Type [round label with red circle along border]. (2) N. Sonora, / Mexico. / Morrison. (3) Brit. Mus. / 1905–88. (4) B.C.A. Neuropt. / Tricorythus / explicatus, / Eaton. Pinned, in poor condition; thorax and right forewing are all that remains on pin; 3 slides which include: (1) left forewing; (2) 1 set of legs; (3) approximately 2/3rd of abdomen and genitalia. *Paralectotypes:* 4 male imagos, pinned, in excellent condition; collection data and all other labels exactly same as lectotype specimen, except each specimen with a circular

paratype label with faded yellow circle along border (added by Kimmins 1934).

Other material examined.—GUATEMALA: BAJA VERAPEZ: Río La Estancia at Hwy. 17, Salana (N15°05′54″; W90°18′18″, elev. 3000 ft), 07.i.2007, 55 L, DEB (TAMU). SANTA ROSA: unnamed creek at Hwy. 16, ca. 13.2 Km S. from Hwy. 16/CA 1 jct, between Km marker 78 & 79 (N14°11′51″; W90°21′38″, elev. 2095 ft), 06.i.2007, 14 L (TAMU). MEXICO: AGUASCALIENTES: Sabinolandia, Río San Pedro, El Salto de los Salados (N21.85; W02.49), 06.xii.1997, 2 L (TAMU). MEXICO: stream at 56 km. between Toluca and Zitaeuaro 4 km. N.E. Bosencheue (elev. 8200 feet), 24.viii.1977, 4 L, RK Allen (CAS). QUERETARO: Puerta de Alegriax, Arroyo Los Zunigas (N20°20′28″; W100°07′10″, elev. 2000 m), 08.vii.2000, 1 L, WDS (TAMU); 1 km S. San Miguel Palmas, Rio Victoria (N21°05′13″; W99°57′10″), 09.vii.2000, 100+L, WDS (TAMU); Bucareli, Río Estorax (N21°02′05″; W99°37′03″), 11.vii.2000, 12 L, WDS (TAMU); 1 Km. S. Huasquilico, Arroyo Jalpan (N21°09′04″; W99°34′42″, elev. 1725 m), 11.vii.2000, 1 L, WDS (TAMU).

UNITED STATES: ARIZONA: *Cochise Co.*; San Pedro R., Luis Springs, 17.iv.2001, 22♂, D. Rees (TAMU); San Pedro River, Hereford Rd. Bridge, 26.xi.1999, 14♂, A.B. Richards (TAMU); San Pedro River, Rt. 80, Saint David, 1.v.1995, 21 L, BCK (TAMU); *Cochise Co*, San Pedro River, Riparian Nat. Cons. Area, Rt. 90, 30.iv.1995, >100♂, BCK (CSU). *Coconino Co.*; Oak Cr. at Hwy. 89A, ca. 5 mi. N. Sedona (N34°55′23″; W111°44′01″), 04.vi.2000, 4 L, DEB (TAMU); Oak Cr. at Manzanita Camp Ground (Hwy. 89), Coconino Nat. Forest (N34°56′04.1″; W111°44′46.0″), 25–26.v.1999, 16 L, DEB (TAMU); Oak Cr. at Pine Flat Camp Ground (Hwy. 89) (N35°00′52″; W111°44′26″), 03–05.vi.2000, 15 L, 3♀ (reared), DEB (TAMU); Oak Creek at Bootlegger Camp Ground, Hwy. 89A, Oak Creek Canyon (N34°58′09.4″; W111°45′01″, elev. 5210 ft.), 24.v.2004, 20 L, 2♀ (reared), 1♂ (reared), DEB (TAMU). *Graham Co.*; Gila R. at Ft. Thomas Road, Ft. Thomas (N33°02′59″; W109°58′01, elev. 2660 ft.), 27.v.2004, 1 L, DEB (TAMU). *Greenlee Co.*; San Francisco R. at FS Rd. 212, ca. 1 mi. N Clifton (N33°04′30″; W109°18′03″, elev. 3700 ft.), 21.v.2004, >100 L, DEB (TAMU). *Santa Cruz Co.*; Patagonia State Park, Sonoita Creek, 22.iii.1987, 3 L, R. Leschen (TAMU); Sonita Cr. at Blue Haven Rd., just off Hwy. 82, ca 1 mi. SW Patagonia (N31°30′57″; W110°47′35″), 06.vi.2000, 2 L, DEB (TAMU); Sonoita Cr., nr. Patagonia, 15.iii.1997, 1♂, J. Slusark & K. Byrnes (TAMU). *Yavapai Co.*; Bubbling Springs off Forest Service Rd. 134, ca. 1 kn N. Page Springs, 22.iv.1993, 4 L, S.R. Moulton and K.W. Stewart (TAMU); Oak Cr. at Page Springs Rd (Co. Rd. 50), Page Springs (N34°45′57″; W111°53′27″, elev. 3455 ft), 25.v.2004, >75 L, DEB (TAMU); Verde R. @ Hwy. 260, Camp Verde (N34°32′60″; W111°51′00″, elev. 3140 ft.), 23.v.1999, 4♂, 8♀ (reared), 38 L, DEB (TAMU); Verde R. @ Hwy. 260, Camp Verde (N34°32′60″; W111°51′00″, elev. 3140 ft.), 23.v.1999, 6♂ (reared), 9♀ (reared), 25 L, DEB (TAMU); Verde R. @ Perkinsville bridge, ca. 16 mi. N. Jerome on FSR 318, Prescott Nat. Forest, 6.vi.1993, 2 L, S.R. Moulton and K.D. Alexander (TAMU); Verde River @ US Hwy. 89A bridge, Cottonwood, 4–5.vi.1993, 38♂ and ♀ imagos, S.R. Moulton and K.D. Alexander (TAMU); West Clear Creek at Clear Creek Campground, ca. 1 mi. from Hwy. 260, ca. 4 mi SE Camp Verde (N34°30′55″; W111°45′45″, elev. 3270 ft.), 26.v.2004, 11 L, DEB (TAMU); East Verde River, Camp Verde, 29.iv.1995, 2 L, BCK (CSU); Oak Creek, Red Rock Crossing, 20.i.1988, 1 L, 1♂, 1♀, BCK (CSU). COLORADO: *Arapahoe Co.*;

South Platte R., Mineral Rd., 23.v.1993, 25♂, S. Fitzgerald (TAMU). *Archuleta Co*, Piedra River, Rd. 193, 1.vii.1996, 26♂, BCK (CSU). *Boulder Co.*; South Boulder Creek, Baseline Rd., 3.x.1995, 16♂, BCK (TAMU). *Chaffee Co*, Trout Cr, F.R. 215 and US 285, 4.ix.1993, 5♂, BCK & R. Durfee (CSU). *Costilla Co*, Trinchera Creek, 12 Road, 30.vi.1996, 9 L, BCK (CSU). *Douglas Co.*; Deckers Resort, BLT, 23.viii.1988, 6♂, P.A. Opler (CU); South Plate, Trumbull, 10.ix.1993, 12♂, 10♀, K. Rogers, (CSU). *Garfield Co*, 31.viii.1975, 1♂, 1♀, D.E. Ruiter (CSU). *Gunnison Co.*; Gunnison River, Riverway Picnic Area, 3 mi. W. of Gunnison, 31.viii.1991, 22♂, BCK, R. Durfee (TAMU). *Jackson Co.*; Grizzly Creek, Peterson SWA, off Rt. 14, 28.vii.1991, 4 L, R. Durfee & B. Painter (TAMU); North Platte River, Verner SWA, 7 mi. SW of Walden, 22.viii.1991, 42♂, R. Durfee (CSU). *Kit Carson Co*, South Fork Republican, N of Stratton, 17.vii.1986, 4 L, 16♂, BCK (CSU). *Larimer Co.*; Buckhorn Creek, about 6 miles west of Horsetooth Reservior, 12ix.1986, 4♂, G.W. Gerlich (TAMU); Head of Spring Creek, Stream, 11.ix.1986, 4♂, D. Brigham (TAMU); Mail Cr., BLT, 14.x.1988, 3♂, P.A. Opler (TAMU); Poudre River, nr. N. Colorado Nature Area, 21.ix.1986, 6 L, 39♂, BCK (TAMU); Ft. Collins, 27.vii.1979, 2♂, D.E. Ruiter (CSU); Heatheridge & Prospect, 27.vii.1979, 6♂, D.E. Ruiter (CSU); Mail Creek, Fort Collins, 10.xiii.1989, 40♂, P.A. Opler (CSU); Poudre R., Shields St. Br. Ft. Collins, 14.ix.1986, 1 L, 3♂, S. Klahn (CSU). *Moffat Co.*; Yampa River, Echo Park, Dinosaur NM, 19.vii.1993, 18♂, 4♀, 2 L, BCK & R. Durfee (CSU); Yampa River, Tee Pee Campground, Dinosaur NM, 28.vii.1995, 38♂ (TAMU); Green River, Echo Park, Dinosaur NM, 24.vii.1992, 2 L, DAW (CSU); Yampa R., Craig, 15 L, (CSU). *Montezuma Co*, Mancos River, Mancos Canyon, Mesa Verde NF, 10.vii.1998, 7 L, BCK (CSU); Mancos River, Rt. 666, 18.vii.1990, 53♂, BCK (CSU). *Rio Blanco Co.*; Douglas Creek @ Rt. 64, 19.vii.1996, 23 L, 18♂, 15♀, BCK & R. Durfee (TAMU). *Saguache Co*, Indian Springs NA, 15.viii.1999, 1♂, BCK (CSU). *Weld Co*, 9.ix.1986, 1♂, D. Thompson (CSU); Lone Tree Creek, Terry Ranch, 10 mi. NW Carr, 17.vi. 1989, 4♂, 1♂ , P.A. Opler (CSU). *Yuma Co.*; S. Fork Republican R., US Hwy. 385 bridge, 29.iv.1993, 18 L, BCK & R. Durfee (TAMU); Arikaree River, Bowman Ranch, 23.vi.1999, 1 L, G. Doyle, (CSU). MISSOURI: *Dallas Co.*, Niangua R. at Hwy. M, 3.5 mi. E. jct. with Hwy. 38 (N37°31′11″; W92°59′03″, elev. 1,120 ft), 10.viii.2005, 3 L, DEB (TAMU). MONTANA: *Big Horn Co*, Big Horn River, 5.ix.1991, 17♂, D.E. Ruiter (TAMU). NEBRASKA: *Garden Co*, Blue Ck, Rackett Rd., 22.v.1998, 3♂, 8♀, BCK (TAMU). *Keith Co*, Otter Ck., St. Hwy. 92, 22.v.1998, 11 L, 2♀, BCK (TAMU). *Sioux Co*, Sowbelly Canyon, 6 mi. NE of Harrison, 12.vi.1989, >300♂, BCK (CSU). NEW MEXICO: *Catron Co.*; San Francisco R., Gila National Forest, ca. 5 mi. S. Glenwood (N33°14′18″; W108°52′47, elev. 4560 ft.), 20.v.2004, 2♂ (reared), >100 larvae, DEB (TAMU); creek at FS Road 233, ca. 5 mi. NE Reserve, Gila National Forest (N33°43′54″; W108°42′28″, elev. 5960 ft.), 20.v.2004, 1 L, DEB (TAMU); Middle Fork Gila R., Gila National Monument (N33°13′47″; W108°15′58″, elev. 5720 ft.), 18.v.2004, 7 L, DEB (TAMU); Taylor Creek, above Wall Lake, 02.viii.1993, 12 L, >50 adults, R. Durfee (TAMU). *Grant Co.*; Gila R., Gila Riparian Reserve, Gila Wilderness, ca. 6.7 mi. NE Cliff (N33°02′39″; W108°31′47″, elev. 4650 ft.), 19.v.2004, 6 L, DEB (TAMU). *Lincoln Co.*; Río Ruidoso at Main St. in Ruidoso (N33°19′14″; W105°42′43″, elev. 4000 ft), 22.v.2000, 5 L, DEB (TAMU). *Sandoval Co.*; Jemez R. at Vista Linda Camp Sight (Santa Fe Nat Forest),

Hwy. 4, ca. 5 mi. N. Jemez Puebloa (N35°43′02″; W106°43′17, elev. 5865 ft.), 12.vii.2004, >75 L, 5♂ (reared), 5♀ (reared), DEB (TAMU); same but, 26,27. v.2000, 3♀ (reared),17 L, DEB (TAMU); Río Guadalupe at Hwy. 485, ca. 2 mi. N. Gilman (N35°44′11″; W106°45′52″, elev. 6190 ft.), 12.vii.2004, 3 L, DEB (TAMU). *San Miguel Co.*; Pecos R. at Santa Ana FR, San Jose (N35°24′10″; W105°28′30″, elev. 6100 ft.), 14.vii.2004, 29 L, DEB (TAMU). *Sierra Co.*; Palomas Creek, 5 mi. W. of Williamsburg, 24.iv.1994, 20 L, >100♂ imagos, R. Durfee (CSU). SOUTH DAKOTA: *Lawrence Co*, Boxelder Creek, Boxelder Forks Campground (N44°11′57″; W103°32′05″), 12.vii.1997, 9♂, Baumann and BCK (TAMU); Redwater River, S. of Belle Fourche (N44°35′36″; W103°52′10″), 13.vii.1997, 10♂, Baumann & BCK (TAMU). *Fall River Co*, Fall River, Hot Springs, 5.ii.1995, 3 L, 1♂, 1♀, BCK (CSU). TEXAS: *Brewster Co.*; Big Bend National Park, Santa Elena Canyon, Rio Grande (N29°09′55″″; W103°36′39, elev. 2200 ft.), 23.iv.2004, 2♀ (reared), DEB (TAMU); same but, 12.v.2002, 16 L, 1♂ (reared), 3♀ (reared) DEB (TAMU); Calamity Cr. @ TX Hwy 118, ca. 22 mi. S. Alpine, 21.x.1993, 50♂ imagos, SR Moulton and JC Abbott (TAMU). *Comal Co.*; Sattler, Rio Raft Co., Guadalupe River @ 5.5 mi. below Canyon Dam below 4th X-ing, 26.x.1996, 2♂ imagos, N. Wiersema (TAMU). *Gillespie Co.*; Sandy Creek at Park Rd. 965, Enchanted Rock State Park, 07.iv.2001, 4♂ (reared), 14♀ (reared), 100+ L, DEB (TAMU). *Hemphill Co.*; Canadian R. at Hwy. 83, ca. 2 mi. N. Canadian (N35°56′09″; W100°22′15, elev. 2321 ft), 29.v.2002, 1 L, DEB (TAMU). *Jeff Davis Co.*; Davis State Park, Limpia Creek, 17.x.2000, 34 L, D. Wood and K. Winther (TAMU); H.C. Espy Ranch, Farm Rd. 1832, 14.v.1973, 30♂, R.G. McClure (TAMU); Limpia Ck. @ Hwy. 118, ca. 1 mi. W. Ft. Davis (N30°36′17″; W103°53′51, elev. 4943 ft), 14.v.2002, 1 L, DEB (TAMU); roadside Pk., stream 2 mi. N. Ft. Davis at St. Rd. 17, 20.vii.1968, 28♂, K.W. Stewart, B. Stark, and G.L. Atmar (DEB); Limpia Creek, Fort Davis, 10.iv.1935, 5 male imagos (pinned), INHS. *Presidio Co.*; Rio Grande, Grassy Banks Access Area on Big Bend Ranch State Park, 24.viii.1996, 1♀ (reared), DEB & D.E. Bowles (TAMU); Big Bend Ranch State Park @ Ojito Adentro (N29°29′27.4″; W104°03′49.9), 24.viii.1996, 4 L, 1♂, DEB (TAMU). *Reeves Co.*; unnamed ck., Hwy 17, Balmorhea (N30°59′13″″; W103°44′35, elev. 3341 ft), 04.v.2002, 11 L, DEB (TAMU). *Val Verde Co.*; Dolan Falls Preserve, Dolan Creek; The Nature Conservancy (N29°53′41″, W100°59′11″), 08.xi.1998, 3♂, DEB (TAMU). UTAH: *Uintah Co*, Green River, Cub Cr. Rd, 23.viii.1990, 12♂, BCK (CSU). VERMONT: *Bennington Co.*; Batten Kill R., Arlington at Rt. 7a (N45°5.8′; W73°8.5″), 17.vii.2004, 1♂ (reared), 2♀ (reared), S.K. Burian (TAMU). WYOMING: *Albany Co*, Laramie River, Hwy. 30, 2.ix.1989, 24 reared ♂, ♀ (imagos and subimagos), M. Harris (TAMU). *Carbon Co*, North Platte River, 1 mile above Treasure Island, 26.viii.1986, 1♂, 1 L, Keith (CSU). *Platte Co*, Spring Fed pond, Warm Spring, Guernsey, 17.ix.1999, 20♂, 2 L, BCK & Doyle (TAMU); same but, 27.ii.2000, 1♂, BCK & Zuellig (CU); North Platte River, Camp Guernsey, 26.viii.2000, 15♂, 1♀, 3 L, BCK (CSU).

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